17707 U.S. PTO
031604

ROTARY PROBE FOR CLEANING AN INTERNAL CAVITY

Field of the Invention

[0001] This invention relates to efficiently dislodging foreign material from an internal cavity of an object such as a turbine blade and, in particular, to dislodging foreign material from hereto for relatively inaccessible regions inside an airfoil cavity.

Related Application

[0002] This invention relates to U.S. Patent Application serial number 10/271,681 entitled Apparatus and Method for Cleaning Airfoil Internal Cavity, filed on October 15, 2002 and assigned to the assignee of the present invention and which is incorporated herein by reference.

Background of the Invention

[0003] The turbine blades found in most, if not all, jet engines in use today are cooled by passing a coolant through the interior of the blade. The coolant cavity typically has a torturous path of travel and may include one or more 180° turns. During use of the engine or repairs performed on the parts, foreign matter may enter the cavities of the engine blades and become adhered to the walls of the cavities, particularly in the hard to reach bend regions. In an effort to dislodge foreign matter from the walls of the blade cavities, metal wires of varying diameters are passed into the blade cavities through openings in the blade roots and the wire is turned at a speed that is sufficient high enough to dislodge any foreign material that it comes in contact with. This type of device works well in easy to reach locations. However, the wires cannot readily contact foreign matter that has lodged in the hard to reach areas. In addition, the flexible wire has a tendency to hang up on the walls of the cooling cavity making maneuvering of the probe rather difficult.

Summary of the Invention

[0004] It is therefore an object of the present invention to more thoroughly dislodge foreign material from an internal cavity of an object such as the cooling cavity of a turbine blade.

[0005] It is a further object of the present invention to improve means for dislodging foreign matter from the internal cavity of an object.

[0006] A still further object of the present invention is to provide a probe for dislodging foreign material that is located in hard to reach internal areas of an object.

[0007] These and further objects of the present invention are attained by a probe having a wire that passes through a tubular guide so that the wire may be rotated within the guide. The distal end of the guide is bent at an angle whereby the guide can be inserted into an internal passage of an object and the wire directed into a hard to reach region to dislodge unwanted foreign material from the hard to reach region.

Brief Description of the Drawings

[0008] For a better understanding of these and other objects of the invention, reference will be made to the following detailed description of the invention which is to be read in connection with the accompanying drawing, wherein:

[0009] FIG. 1 is illustrates a turbine blade in cross section that is mounted within a holding fixture and an elongated probe embodying the teachings of the invention is shown passing upwardly into a blade cavity through an opening in the blade root.

[0010] FIG. 2 is an enlarged view in section of the upper part of the blade cavity showing the probe positioned adjacent a difficult to reach bend region; and

[0011] FIG. 3 is an enlarge side elevation in partial section further illustrating the probe of the present invention in greater detail.

Detailed Description of the Invention

[0012] Turning now to the drawings there is illustrated in Fig. 1 a turbine blade, generally referenced 10, that has been removed from a jet engine. Although this disclosure will be made with specific reference to a jet engine turbine blade, it should be understood that the present invention can be utilized in association with any object containing an internal cavity that may entrap foreign material. The root 12 of the blade is mounted within a holding fixture 13 arranged to securely hold the blade in a desired position while at the same time permitting free access to openings 15 leading to an internal cooling cavity 16 through the root of the blade.

[0013] The cooling cavity, as is typical in most turbine blades, follows a torturous path of travel having difficulty to reach regions such as the bend area 17 located in the top section of the blade. Normally, an unsupported straight length of flexible wire that is typically used to dislodge foreign matter 18 from the cavity will not be able to effectively penetrate this bend area.

[0014] A probe or dislodging tool, generally referenced 20, that embodies the teachings of the present invention is illustrated in greater detail in Figs. 2 and 3. The probe includes an elongated tubular wire guide 22 that is capable of being inserted upwardly through a root opening in the blade. Preferably, the guide is fabricated of a rigid material such as a length of stainless steel tubing. The guide is of sufficient length such that the guide can extend the full length of the entrance passage to a point adjacent to the hard to reach region 17 typically located at the top of the passage. The tip 24 of the guide is bent at an angle with regard to the axis 25 of guide so that the opening at the distal end of the guide can be directed at the hard to reach region. The length of the bend is relatively short so that the guide is able to move freely through cooling passage without snagging upon the passage wall. It has been found that an angle of about 30° at the tip of the guide works well in most blade applications. The angle may be adjusted, however, depending on the specific application.

[0015] The lower section of the guide can be housed within a tubular sleeve 26 so that the sleeve can rotate about the axis of the guide. A close running fit may

be provided between the outer wall of the guide and the inner wall of the sleeve so that the sleeve can turn freely about the axis of the guide without wobbling. It has been found that good results are realized when the sleeve extends upwardly from the bottom of the guide to about half way up the guide. A flexible metal wire 32 is passed upwardly through the center opening in the guide so that both the top end section 33 and the bottom end section 34 of the wire extend outwardly from both the distal and proximal ends of the guide. Here again a close running fit is provided between the inner wall of the guide and the outer surface of the wire so that the wire can turn freely about the axis of the guide as well as being moved axially within the guide.

[0016] The bottom section of the wire can be secured to the outer wall of the sleeve. As shown in Fig. 3, the wire is turned around the bottom of the sleeve. Preferably, the wire is held against the outer surface of the sleeve by means of an adjustable chuck 40 that is mounted upon a driver 42. The motor in practice may be battery driven or connected to a readily available 120 volt outlet. The jaws 41 of the chuck are arranged to close over both the sleeve and the wire. Sufficient closing force is applied by the jaws to crimp the wire securely against the outer surface of the sleeve whereby both the wire and the sleeve can be rotated together at a desired speed. As can be seen, the guide is not turned as the chuck rotates and accordingly the distal end of the guide cap be directed into a hard to reach region.

[0017] Although the wire is secured to the sleeve of by the jaw of an adjustable chuck in this embodiment of the invention, it should be clear that any suitable means for securing the wire to the sleeve can be employed without departing from the teachings of the present invention. Such techniques may involve welding or brazing the wire to the sleeve or simply wrapping the wire around the sleeve.

[0018] In the practice of the present invention, the bent tip of the wire guide is brought adjacent to the hard to reach region and is pointed directly at the region. Sufficient wire is extended outwardly from the tip so that the wire will be able to contact any foreign material in this region. The cojoined wire and sleeve are then rotated at a relatively high speed to dislodge this unwanted material from the region and the dislodged material then be easily flushed from the cooling cavity.

Positioning of the probe within the cooling cavity can be accomplished using well known x-ray imaging techniques.

[0019] While the present invention has been particularly shown and described with reference to the preferred mode as illustrated in the drawing, it will be understood by one skilled in the art that various changes in detail may be effected therein without departing from the spirit and scope of the invention as defined by the claims.